Using Multiple Regression Models to Understand the Influence of Geologic History, Topography, Island Size, Isolation and Dispersability on Plant Community Assemblage in the Western Aleutian Islands

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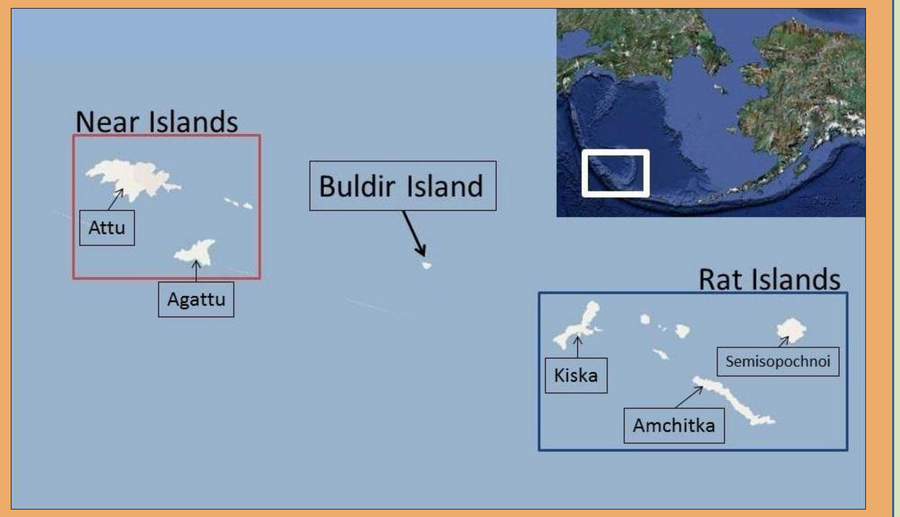
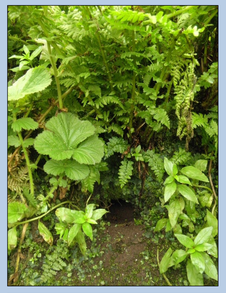
Introduction: Island groups are often subject to habitat filters and dissimilar dispersal sources, and as a result may reflect dissimilar plant assemblages between islands. Though the Aleutian Islands have likely acted as a route for plant dispersal across the North Pacific, many continental endemics have colonized the islands but have not dispersed over the chain as a whole (Talbot, 1994). Typically, North American endemic plant species represent an increasing proportion of the flora with closer proximity to the Alaskan mainland, while Asian endemics increase in proportion towards Kamchatka (Lindroth, 1961). Using plant species occurrence data across the Western Aleutian Islands, we may examine the impact of several barriers to dispersal and flora assemblage.



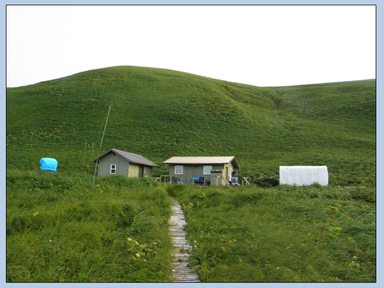
The Western Aleutian Islands are composed of the Near Islands group in the west, the Rat Islands in the east, and a small, isolated, densely seabird-inhabited island, Buldir Island.

Influence From the Environment or Seabirds?

Several recent papers (Croll et al., 2005; Maron et al., 2006) suggest that seabirds have created a habitat filter across the Aleutian Islands through chemical and physical soil disturbance. Our analysis will determine if seabird influence has shaped the regional phylogenetic structure of plant communities.



Athyrium filix-femina, *Geum macrophyllum*, and *Epilobium behringianum* are a few of the plant species which grow near seabird burrows.



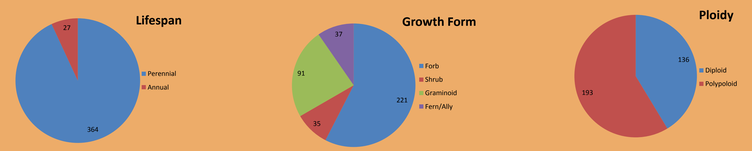
Those Aleutian islands which are historically free of predators, such as Buldir Island (pictured above), are often densely populated with burrowing, crevice and surface nesting seabird colonies. The hillside behind the cabins has many thousands of Storm-Petrel burrows, and an associated lush vegetation.

Salix (willow) species are common throughout alpine regions in the Aleutian Islands, but are rarely found in the lush near-shore or burrowing seabird-associated vegetation. The wind-dispersed seeds of *Salix* may easily travel between islands, but they must also be able to grow where the seeds land.

Aleutian alpine environments are considerably diverse floristically.

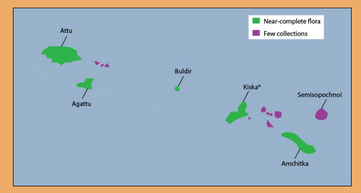
Results & Discussion: We collected species occurrence data for 382 species across the Western Aleutians. There were on average many more collections from larger islands and from those islands with WWII activity. Several islands in the region, including the large Semisopochnoi Island, have incomplete floras, and more effort should be directed into basic botanical collecting. The island with the largest floral diversity is Attu Island, which is the largest in area and has a long history of botanical collecting. Efforts are being made to increase the accuracy of the beta diversity matrix to allow for more delineation between islands before running multiple regression models.

Summary of Western Aleutian Plant Taxa



Island	Island Group	Area (km2)	Elev. (m)	Volcanic	Foxes	Taxa	Taxa/area	Steepness	Age
Buldir	N/A	19.29	620	1	0	126	6.531881804	32.141006	Quaternary
Alaid	Near Islands	6.9	29.6	0	1	74	10.72463768	4.2898551	Tertiary
Shemya	Near Islands	15.29	37.18	0	1	10	0.654022237	2.4316547	Tertiary
Nizki	Near Islands	8.05	50.29	0	1	10	1.242236025	6.247205	Tertiary
Agattu	Near Islands	221.6	632	0	1	197	0.88898917	2.8519856	Tertiary
Attu	Near Islands	893	860	0	1	307	0.343784994	0.9630459	Tertiary
Khvostof	Rat Islands	2.5	265	0	1	21	8.4	106	Quaternary
Davidof	Rat Islands	3.7	330	1	1	24	6.486486486	89.189189	Quaternary
Segula	Rat Islands	35.3	1159	1	1	0	0	32.832861	Quaternary
Little Sitkin	Rat Islands	73	1188	1	1	0	0	16.273973	Quaternary
Semisopochnoi	Rat Islands	224	1221	1	1	26	0.116071429	5.4508929	Quaternary
Little Kiska	Rat Islands	8.1	74	0	1	5	0.617283951	9.1358025	Tertiary
Rat	Rat Islands	26.7	206	0	1	81	3.033707865	7.7153558	Tertiary
Amchitka	Rat Islands	309	300	0	1	242	0.783171521	0.9708738	Tertiary
Kiska	Rat Islands	278	1220	1	1	168	0.604316547	4.3884892	Tertiary

A summary of island variables in the Western Aleutians.



There have been few botanical collections for several of the smaller islands, but there have been near-complete collections from Buldir Island and the largest islands in the region: Attu, Agattu, Kiska and Amchitka.

Literature Cited: **Amundsen, C.C.** (1977) Terrestrial plant ecology. *The Environment of Amchitka Island, Alaska*. (ed M.L.M. and R.G. Fuller), pp. 203–226. Energy, Research, and Development Administration. **Croll, D.A., Maron, J.L., Estes, J.A., Danner, E.M. & Byrd, G.V.** (2005) Introduced predators transform subarctic islands from grassland to tundra. *Science*, **307**, 1959-61. **Hulten, E.** (1960) *Flora of the Aleutian Islands*. J. Cramer, New York, NY. **Ihaka, R. & Gentleman, R.** (1996) R: a language for data analysis and graphics. *Journal of Computational and Graphical Statistics*, **5**, 299-314. **Kubota, Y., Hirao, T., Shin-jiro, F. & Murakami, M.** (2011) Phylogenetic beta diversity reveals historical effects in the assemblage of the tree floras of the Ryukyu Archipelago. *Journal of Biogeography*, **38**, 1006-1008. **Lindroth, C.H.** (1961) The Aleutian Islands as a route for dispersal across the North Pacific. *Pacific Basin Biogeography - A Symposium*. (eds J.L. Gressit, C.H. Lindroth, F.R. Fosberg, C.A. Fleming & E.G. Turbott), pp. 121-182. Bishop Museum Press. **Lozupone, C. & Knight, R.** (2005) UniFrac: a new phylogenetic method for comparing microbial communities. *Applied and Environmental Microbiology*, **71**, 8228-8235. **Maron, J.L., Estes, J.A., Croll, D.A., Danner, E.M., Elmendorf, S.C. & Buckelew, S.L.** (2006) An introduced predator alters Aleutian Island plant communities by thwarting nutrient subsidies. *Ecological Monographs*, **76**, 3-24. **Shacklette, H.T., Durrell, L.W., Erdman, J.A., Keith, J.R., Klein, W.M., Krog, H., Persson, H., Skuja, H. & Weber, W.A.** (1969) *Vegetation of Amchitka Island, Aleutian Islands, Alaska. Geological survey professional paper 648.* **Talbot, S.S. & Talbot, S.L.** (1994) Numerical classification of the coastal vegetation of Attu Island, Aleutian Islands, Alaska. *Journal of Vegetation Science*, **5**, 867-876. **Webb, C.O., Ackerly, D.D. & Kembel, S.W.** (2008) Phylocom: software for the analysis of phylogenetic community structure and trait evolution. *Bioinformatics*, **24**, 2098-100.

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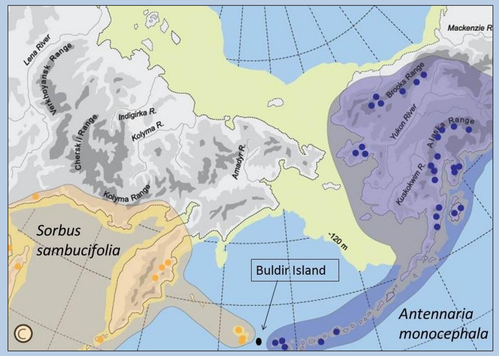
Methods: Plant species occurrence data in the Western Aleutian Islands was collected from recent field work efforts, historical literature records (Hultén, 1960; Shacklette, 1969; Amundsen, 1977), as well as data from distributed databases. Matrices of phylogenetic beta diversity were then created by assembling a phylogenetic supertree of the regional taxa using Phylocom (Webb et al., 2008) and then submitting the taxa tree with island occurrence data to Unifrac (Lozupone & Knight, 2005). Matrices of beta diversity were used to delineate the islands in the study area for model testing and to reveal strong influences on community assemblage. Matrices of explanatory variables including seabird habitation, volcano presence, island size, topography, and distance were then created to be submitted to a multiple regression model using R (Ihaka & Gentleman, 1996) along with the beta diversity matrix.

Two month-long field seasons (2010-2011) were spent on Buldir Island surveying the vegetation, particulary around seabird colonies. Short trips to other Western Aleutian Islands were made during 2010-2011 as well, including Attu, Kiska, and Rat Island.

Limited Species distributions

Many plant species have limited, disjunct, or rare populations across the Aleutian Islands. This could be the result of few colonizations from mainland sources, poor surviviability, competition, or more ancient impacts such as volcanic eruptions and glaciation.

Aconitum maximum, a close relative of Monkshood, is found in the far-west Aleutians and throughout most of the Eastern Aleutians, but is absent from the Central-Aleutian Rat Islands group.



Species *Sorbus sambucifolia* and *Antennaria monocephala* both inhabit the Aleutian Islands but do not stretch across the entirety of the island chain.

Parasenecio auriculata, the Eared Indian Plantain, is an Asian Asteraceae species that ranges as far east as Kiska Island.